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PRELIMINARY REPORT ON A PROGRAM TO COMPUTE CONSTANT PROPAGATION--ETC(U)

AUG 64 L T EINSTEIN, A G REIS

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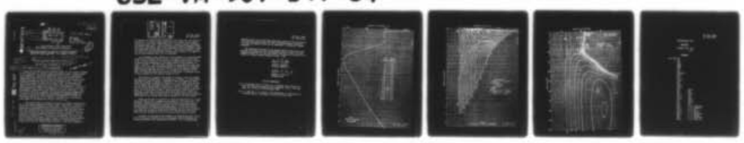

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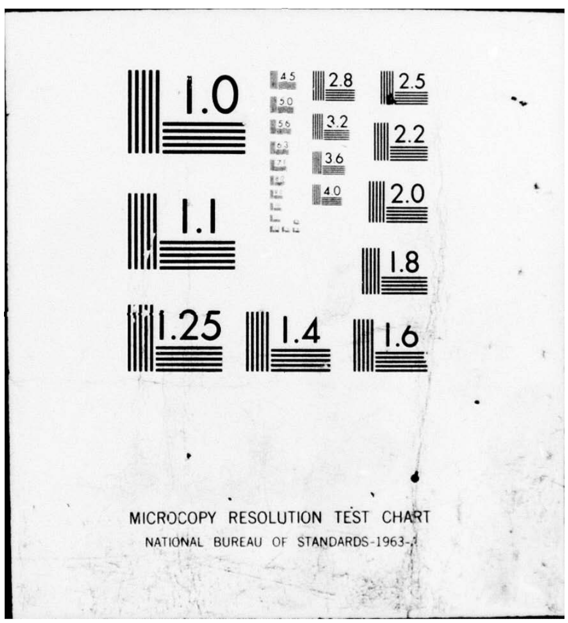
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U. S. Navy Underwater Sound Laboratory
Fort Trumbull, New London, Connecticut

(6) PRELIMINARY REPORT ON A PROGRAM TO COMPUTE CONSTANT PROPAGATION LOSS CONTOURS (USL Program No. 0233).

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by

(10) Lloyd T. Einstein ~~and~~ Arthur G. Reis, Jr

(12) 7 p.

USL Technical Memorandum No. 907-147-64

(14) USL-TM-907-147-64 (11) 18 ~~August 1964~~

MOST Project -12

One of the most difficult problems facing the sonar system designer is the requirement to evaluate system performance under a large variety of circumstances. When hand computations are involved, a parametric study linking the effects of ocean area, source and receiver depths, transmission path, bottom and surface descriptions, and frequency, soon becomes discouraging, even when time and manpower permit. With this situation in mind, the Theory and Analysis Staff is developing some basic computational tools that will reduce these problems, wherever possible, to their simplest and most direct representations. Several of these programs will deal with propagation loss, and others with array performance, reverberation, and, eventually, system performance. Typical of this effort is a program which models near-surface propagation, according to the AMOS equations, ~~as described in reference (a)~~. The ability to examine the entire sound field generated by a source at a fixed depth has proved to be a valuable contribution to the problem, even though no new theoretical work was involved.

The current effort is aimed at producing a similar representation for a sound field generated by deeper, longer range paths to which geometric ray-tracing techniques are applicable. Since no closed form expression for propagation loss as a function of range and depth exists here, the problem is one of following along each ray, storing the set of points at which the total loss equals values of interest. This procedure has been made extremely simple and straightforward by the work described in reference (b). This report demonstrates that each layer can be examined for possible contour values, and these values extracted, without utilizing any approximation methods or inserting additional break points into the velocity-depth structure. With this background,

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USL Program No. 0233 has been designed to investigate the loss contours present in a selectable range-depth window for a given source depth, transmission path (RSR or Bottom Bounce), frequency, bottom loss model, and surface loss model. This program has been severely hampered by the relatively small memory (8K) of the Laboratory's IBM 704 computer, which has complicated the de-bugging procedure. The results obtained to date are still in a preliminary form, and much effort remains to be spent in the plotting programs which will be developed.

As an example of the capability of this program, the velocity-depth structure for a Bermuda area, as given in Figure 1, was selected for study. With the source on the bottom, the spreading-loss field created by shallow rays terminating at the upper vertex, or the surface, is shown in Figure 2. The ray paths selected by the program are also indicated. Here is a most interesting example of spreading loss anomalies, apparently arising when the rays traverse the large negative gradient region between 3940 and 1970 feet. For instance, at a depth of 1700 feet, the predicted sound field varies by less than 1 db between 15 and 30 kyds, compared to the expected change of 6 db.

The ability to "enlarge" any region of interest, either by expanding the plot or recomputing, is demonstrated in Figure 3. Here we have the upper 500 feet of Figure 2, expanded to show the wealth of detail which this program is capable of producing. In the upper right portion of this graph, the vertexing rays show a loss that decreases most rapidly as the vertexing depth is approached. The 70 db contour is shown for this locus, whereas losses as low as 58 db were produced by the program. At 60 feet and 21.6 kyds., extreme bunching of the contours is indicated, resulting at the point where rays just begin to enter the uppermost layer. This picture leads us to consider some basic questions pertaining to ray-tracing, which may be answered in the near future.

First, we are now in a position to study the sensitivity of a large predicted sound field to changes in the quality of the input data. We are aware, through the efforts of NEL and others, that using velocity structures with discontinuous first and second derivatives produces strange effects in predicted convergence zones. We are not, however, in a position to say what might be the simplest cure for this situation. Some light may be shed on the problem if we can see the entire sound field at once, instead of a set of cuts at various receiver depths.

Secondly, we can predict the existence of interesting sound fields, such as the one in Figures 2 and 3, which might lead to programs combining experimental and computational efforts. It is of the greatest

importance that we not only agree with other groups on the best method for predicting sound fields, but that this method agrees reasonably well with the physical world in all situations of interest to system designers.

The techniques utilized in the program described above will also simplify the analysis of the reverberation problem. This, and other programs planned for the next six months, will provide the basis for an attempt at complete system analysis by mid - 1965.

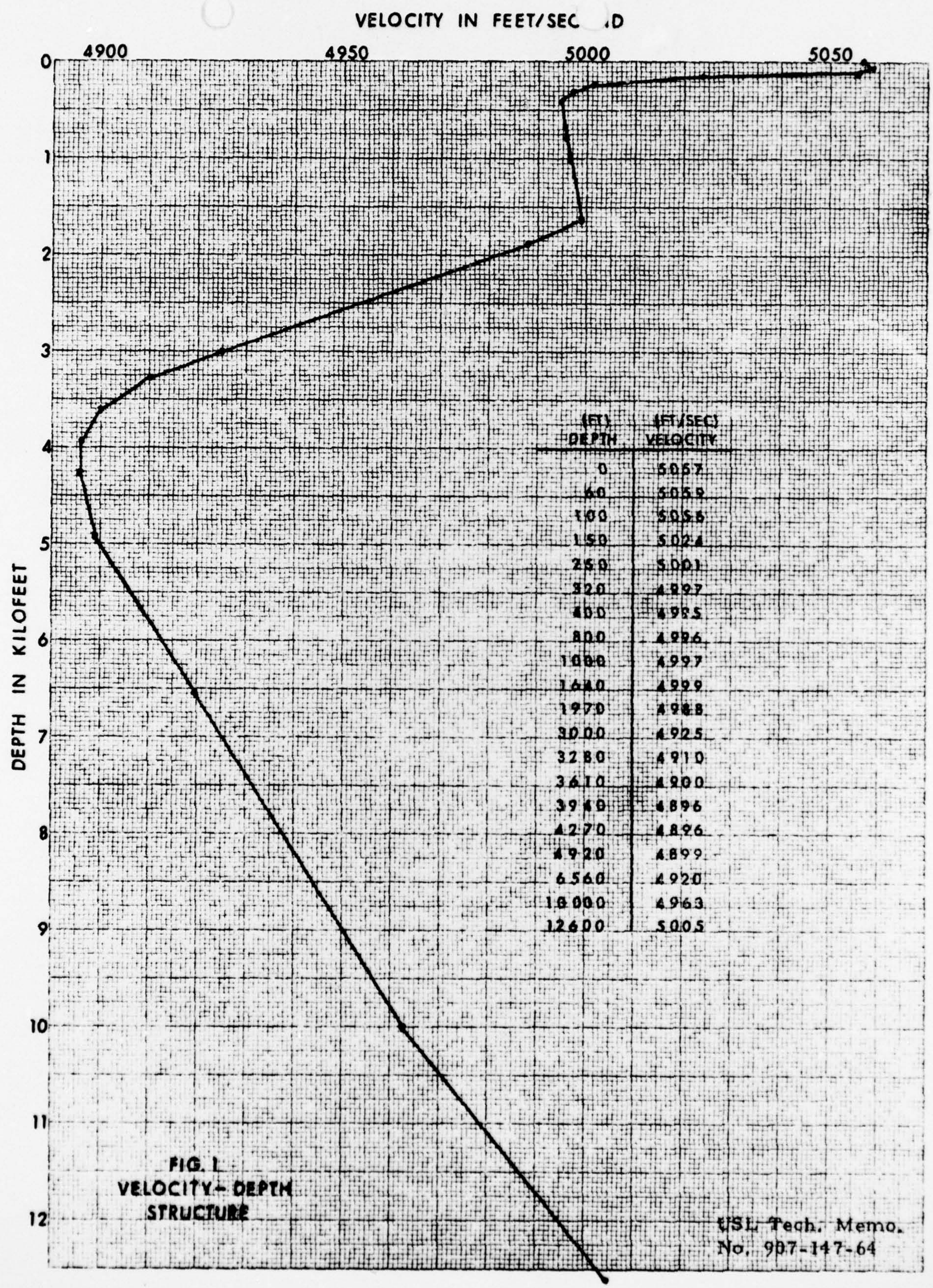
Lloyd T. Einstein
LLOYD T. EINSTEIN
Research Physicist

Arthur G. Reis, Jr.
ARTHUR G. REIS, JR.
Mathematician

LIST OF REFERENCES

(a) L. T. Einstein and A. G. Reis, Jr., "Constant Loss Contours for AMOS Near-Surface Propagation (USL Program No. 0131)," USL Tech. Memo. No. 907-30-64, of 28 February 1964.

(b) E. S. Eby and L. T. Einstein, "The Computation of Spreading Loss in Layered Media," USL Report No. 609, of 8 April 1964



(FT) DEPTH	(FT/SEC) VELOCITY
0	5067
60	5059
100	5056
150	5024
250	5001
320	4997
400	4985
800	4996
1000	4997
1640	4999
1970	4988
3000	4925
3280	4910
3610	4900
3940	4896
4270	4896
4920	4899
6560	4920
10000	4963
12600	5005

FIG. 1
VELOCITY-DEPTH
STRUCTURE

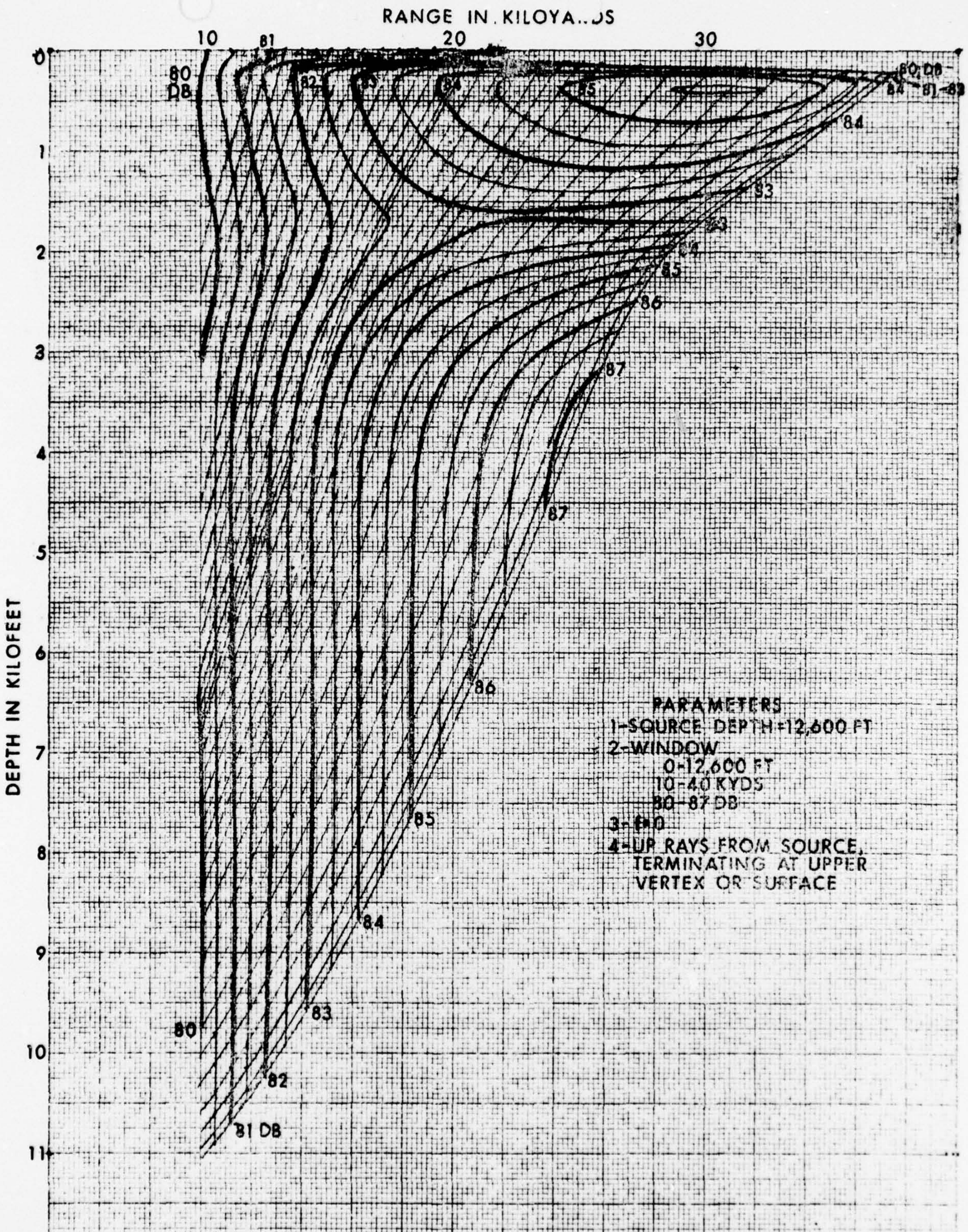


FIG. 2
CONTOURS IN LARGE WINDOW

USL Tech. Memo.
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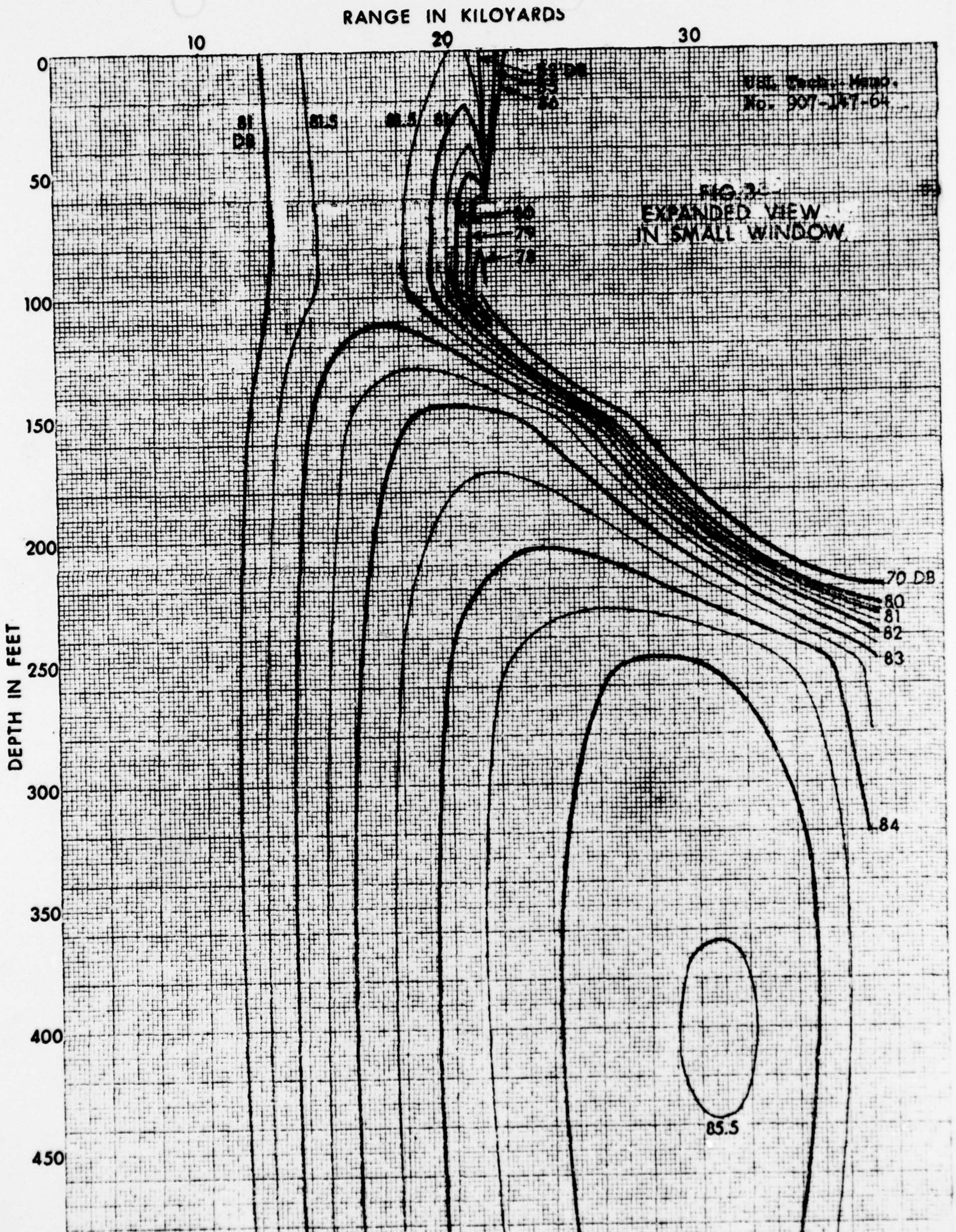

RANGE IN KILOYARDS
10
20
30
DEPTH IN FEET
0
50
100
150
200
250
300
350
400
450
500
USL Tech. Memo.
No. 907-147-64
FIG. 3
EXPANDED VIEW
IN SMALL WINDOW
81
DB
81.5
70 DB
80
81
82
83
84
85.5
81
DB
82
83
84
85
85

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